Thermal Properties of Lunar Regolith Simulants

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Various high temperature chemical processes have been developed to extract oxygen and metals from lunar regolith. These processes are tested using terrestrial analogues of the regolith. But all practical terrestrial analogs contain H_2O and/or OH^-, the presence of which has substantial impact on important system behaviors. We have undertaken studies of lunar regolith simulants to determine the limits of the simulants to validate key components for human survivability during sustained presence on the moon. Differential Thermal Analysis (DTA) yields information on phase transitions and melting temperatures. Themo-Gravimetric Analysis (TGA) with mass spectrometric (MS) determination of evolved gas species yields chemical information on various oxygenated volatiles (water, carbon dioxide, sulfur oxides, nitrogen oxides and phosphorus oxides) and their evolution temperature profiles. The DTA and TGAMS studies included JSC-1A fine, NU-LHT-2M and its proposed feed stocks: anorthosite; dunite; HQ (high quality) glass and the norite from which HQ glass is produced. Fig 1 is a data profile for anorthosite. The DTA (Fig 1a) indicates exothermic transitions at 355 and 490°C and endothermic transitions at 970 and 1235°C. Below the 355°C transition, water (Molecular Weight, MW, 18 in Fig 1c) is lost accounting for approximately 0.1% mass loss due to water removal (Fig 1b). Just above 490°C a second type of water is lost, presumably bound in lattices of secondary minerals. Between 490 and the 970 transition other volatile oxides are lost including those of hydrogen (third water type), carbon (MW = 44), sulfur (MW = 64 and 80), nitrogen (MW 30 and 46) and possibly phosphorus (MW = 79, 95 or 142). Peaks at MW = 35 and 19 may be attributable to loss of chlorine and fluorine respectively. Negative peaks in the NO (MW = 30) and oxygen (MW = 32) MS profiles may indicate the production of NO_2 (MW = 46). Because so many compounds are volatilized in this temperature range quantification of the mass loss associated with individual species is difficult. Similar information will be presented for the other materials studied in this investigation